Original article

Analysis of Maxillary Incisor Tooth Dimensions and Gingival Phenotype in Thai Young Adults

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Abstract

This study aimed to evaluate the association between maxillary incisor tooth dimensions and gingival phenotype in Thai young adults. Two calibrated examiners examined 400 maxillary incisors from 100 subjects. The gingival phenotype was assessed by transparency probing and visual assessment. Clinical parameters, tooth shape, crown width, crown length, and papilla height were measured. Tooth dimensions were analyzed between tooth shapes. Comparison of tooth dimensions between gingival phenotypes was performed by statistical analysis. The results showed that ovoid, square, and triangular teeth presented with similar tooth proportion ($p>0.05$). However, a significantly higher papilla height was found in triangular teeth compared with ovoid and square teeth (mean = 4.26±0.65 vs 3.69±0.74 and 3.63±0.78 mm, respectively, $p<0.05$). The crown length was significantly shorter and tooth proportion was significantly higher in teeth with flat gingival contour than teeth with scalloped gingival contour. Tooth proportion was significantly associated with thin gingival phenotype and scalloped contour gingiva. In summary, there was no difference in tooth dimensions between the tooth shapes evaluated. Lower tooth proportion was found in thin gingival phenotype, thick scalloped- and thin scalloped gingival contour. For clinical assessment, tooth proportion and tooth shape are influenced by papilla height and the gingival contour.

Keyword: Gingival phenotype, Gingival biotype, Maxillary incisors, Tooth dimension, Tooth proportion

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Introduction

Gingival phenotype is the term used for describing gingival architecture.[1,2] The gingival phenotype is determined by soft tissue, bone morphology, and tooth shape.[3] Several other terms have been proposed to reflect these characteristics, such as periodontal phenotype[4,5], periodontal morphotype[6], and periodontal biotype.[1] The gingival phenotype/biotype can be categorized into thick and thin phenotype depending on soft tissue thickness.[7,8] In addition, the gingival contour is defined as the shape of the gingival margin as flat or scalloped.[9,10]

Identifying the gingival phenotype and tooth dimension is often needed for esthetic risk assessment, especially for the maxillary anterior teeth. Different gingival morphologies respond differently to the same treatment. A thick gingival phenotype was found to develop pocket formation in reaction to trauma or inflammation, while a thin gingival phenotype was more prone to react with gingival recession.[7,11] Moreover, thick gingiva heals more predictably after surgery with minimal alveolar ridge resorption.[12] Therefore, the gingival phenotype has a critical effect on restorative treatment outcomes.

Tooth proportion was shown to highly influence dental restoration appearance, especially in the esthetic zone. It has been proposed that the tooth proportion or crown width/crown length (CW/CL) ratio for the maxillary central incisors should be between 75 % - 80 % and within 10 - 11 mm in length. A lower CW/CL results in a narrower tooth, while a higher CW/CL results in a short and square tooth. Thus, to make an esthetically-appealing tooth, clinicians should consider to set a minimum width of 7.5 mm for central incisors.[13] A previous study found that long-narrow teeth exhibited a CW/CL = 0.56±0.04 while that of short-wide teeth was 0.88 ± 0.06.[11]

The gingival phenotype has been demonstrated to correlate with gingival morphology and tooth shape. Thick gingiva was correlated with a square (short-wide) tooth and thin gingiva was found with tapered (long-narrow) teeth.[11] Additionally, a scalloped gingival contour was found with slender teeth.[9] A previous study found that a thick gingival phenotype was correlated with square an triangular teeth, while a thin phenotype was associated with triangular teeth.[9] However, the relationship between gingival phenotype and tooth dimensions remains unresolved. The aim of this study was to determine the relationship between gingival phenotype, tooth shape, and tooth dimensions in maxillary incisors.

Table 1 *The relationship between tooth shape and clinical parameters (Mean (SD)) in the 100 subjects*

Clinical Parameters (mm)	Tooth Shape		
	Ovoid	Square	Triangular
CL	9.72 (0.02)	10.30 (0.41)	10.19 (0.50)
CW	7.40 (0.34)	7.91 (0.23)	7.66 (0.52)
CW/CL	0.77 (0.03)	0.77 (0.02)	0.75 (0.02)
PH	3.70 (0.74)[a]	3.63 (0.78)[a]	4.26 (0.65)[b]

[a, b] *Indicates significant association (p<0.05)*

Materials and methods

The study subjects comprised 105 dental students, 20–24-years old. Sample size calculation was performed. The inclusion criteria were subjects having all 4 maxillary anterior teeth, good oral hygiene, good periodontal health, normal tooth alignment and normal occlusion. The exclusion criteria were a history of orthodontic treatment, periodontal

pockets > 3 mm, or taking medications with any known effect on the periodontal soft tissues. Oral hygiene instructions, tooth prophylaxis, and polishing were provided to all subjects.

The study protocol was approved by the Institutional Review Board at Chulalongkorn University (Study ID: 3200502#45/2013) and was conducted in full accordance with the World Medical Association Declaration of Helsinki of 1975, as revised in 2013. All subjects provided inform consent to participate in the present study.

The subjects' clinical parameters were recorded by two calibrated clinicians (K.K. and P.S.). A periodontal probe (CPU 15 UNC, Hu-Friedy, Chicago, IL, USA) was used to measure probing depth (PD), gingival recession (RE) and papilla height (PH) of the maxillary central incisors to the nearest 0.5 mm, as described in the previous study.[14] Pearson's correlation coefficient of the inter- and intra-examiner reliability was 0.666–1.000 (p<0.01) and the corresponding kappa statistic was 0.767–1.000 (p<0.01).

The gingival phenotype was assessed using 2 methods. Transparency probing was based on the transparency of the periodontal probe through the gingival margin while probing the sulcus at the mid-facial aspect of the 4 incisors. If the outline of the underlying periodontal probe could be seen through the gingiva, it was categorized as thin; if not, it was categorized as thick.[8] Visual inspection was used to categorize the gingival contour into 3 types[9,14]: thin-scalloped, thick-scalloped, or thick-flat gingiva. Clinical photographs of the upper anterior teeth were also taken.

Tooth shape and tooth dimensions were evaluated. The tooth dimensions consist of crown width (CW), crown length (CL), and tooth proportion which is defined as the crown width/crown length ratio (CW/CL). The CW was measured at the border between the middle and cervical regions. The CL was measured from the incisal edge of the crown to the free gingival margin or CEJ. The measurement was performed on the 4 incisors to the nearest 0.1 mm using a caliper (Fig. 1).

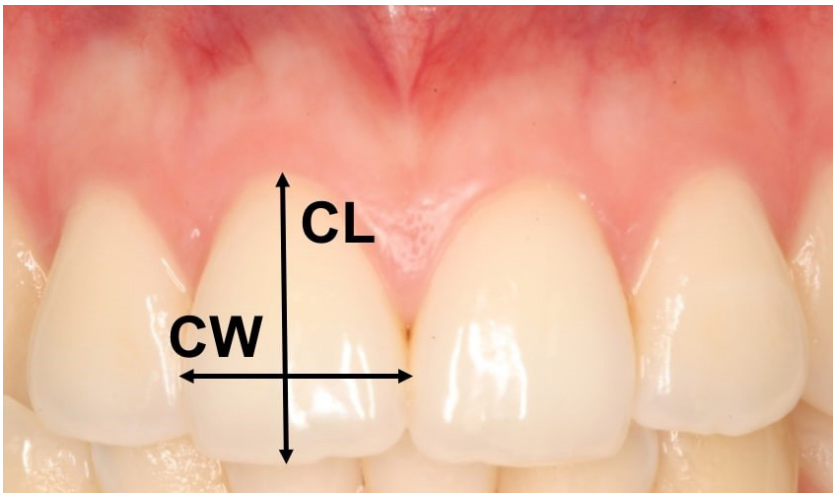

Figure 1 *Measurement of crown width (CW) and crown length (CL)*

Visual inspection was performed to determine tooth shape (TS) based on 3 categories.[15] Square shape was defined as a tooth with parallel interproximal lines. Triangular shape was defined as a tooth with interproximal lines that flared from the gingival margin to the incisal edge. Oval shape was defined as a tooth with interproximal lines that curved towards each other incisally and cervically.

Statistical analysis

To classify our study subjects into subgroups for data analysis, the representative data of each subject

selected based on the most common tooth shape, gingival phenotype, and gingival contour in their anterior teeth, otherwise, those of their central incisor was used.

The prevalence of the gingival phenotype/contour, tooth shape, CW, CL, CW/CL and PH was assessed using descriptive analysis. The association between tooth shape and other clinical parameters was analyzed using the Chi-square test. The data were normally distributed, thus comparison of the tooth dimensions between gingival phenotype/contour was analyzed by independent *t*-Test and ANOVA. A *p*-value < 0.05 was considered significant. All analyses were performed with the SPSS software (SPSS version 16, SPSS Inc., Chicago, IL, USA).

Results

After considering the exclusion criteria, four hundred maxillary incisors from 100 periodontally healthy subjects (42 male and 58 female, mean age 22.2 ±0.84 years) were evaluated. The prevalence of ovoid, square and triangular teeth was 33 %, 38 %, and 29 %, respectively. Thick gingival phenotype presented in 66 % of the subjects. 42 % of the subjects presented with thin-scalloped gingiva, 35 % with thick-scalloped gingiva and 23 % with thick-flat gingiva.

Upon dividing the incisors into three groups, there was no significant difference in CL, CW, or CW/CL between tooth shapes. We found that the ovoid and square type made up with the similar tooth proportion (0.77 mm), but triangular type had lower tooth proportion (0.75 mm). However, a significant association between tooth shape and PH was identified. Triangular teeth presented with a significantly higher PH (mean PH = 4.26± 0.65 mm) compared with ovoid (mean PH = 3.69± 0.74 mm) and square (mean PH = 3.63±0.78 mm) teeth (p<0.05, Table 1).

Table 2 *Comparison of tooth dimensions between gingival parameters (mean (SD), n=400)*

Gingival parameters		Tooth dimensions		
		CW (mm)	CL (mm)	CW/CL
Gingival phenotype	Thick	7.89 (0.33)	9.11 (0.82)	0.87 (0.08)
	Thin	7.79 (0.42)	9.31 (0.75)	0.84 (0.07)*
Gingival contour	Thick flat	7.93 (0.33)	8.70 (0.76)	0.92 (0.07)
	Thick scalloped	7.86 (0.39)	9.39 (0.74)**	0.84 (0.07)**
	Thin scalloped	7.74 (0.42)	9.42 (0.70)***	0.83 (0.06)***

**Indicates a significant difference between thick & thin gingival phenotypes (p<0.05)*

***Indicates a significant difference between thick flat & thick scalloped gingiva (p<0.05)*

****Indicates a significant difference between thick flat & thin scalloped gingiva (p<0.05)*

The tooth dimensions were compared between different gingival parameters (Table 2). The results indicated that teeth with a thick phenotype tended to demonstrate a significant higher CW/CL compared with those with a thin phenotype (0.87±0.08 vs 0.84±0.07). In teeth with a flat gingival contour, the CL was significantly shorter and CW/CL was significantly higher compared with the teeth with scalloped gingival contour (p<0.05).

Discussion

To achieve patient's satisfaction, information about the standard of tooth shape and gingival characteristics should be considered for esthetic outcomes. Thus, an understanding of intraoral structures, such as natural teeth and dentition, as well as gingiva and mucosa, is necessary. This study analyzed the tooth dimension and gingival phenotype in Thai young adults to determine useful standard criteria for dental treatment.

This study analyzed tooth dimension and gingival phenotype in maxillary incisors. Gingival contour has been shown to correlate with tooth shape. A relationship between gingival phenotype and tooth shape was shown in multiple studies, including our previous investigation.[6,9,11,14,16,17] Thick gingiva was associated with a square (short-wide) tooth shape and thin gingiva was found with a tapered (long-narrow) tooth shape. In our study, tooth shape was classified into 3 types and each type was significantly associated with a different gingival contour. A thick-flat gingival contour was associated with square teeth, thick-scalloped gingiva was linked to ovoid teeth, and a thin-scalloped contour was found mostly with triangular teeth.

Tooth proportion was determined by the CW/CL ratio.[1,9,18] Many studies classified anterior tooth shape using the ratio of CW to CL or tooth proportion.[19,20] Our finding demonstrated that similar tooth proportion was presented in ovoid and square type. This corresponded to another study that reported that triangular tooth had the lowest tooth proportion.[9,20] It has been suggested that this ratio of values could act as a stable reference and act as a tool to justify proper tooth proportion.[21] However, some study reported that the width/length ratio of the clinical crown showed little difference based on gender and subject height.[21]

It has been demonstrated that slender teeth commonly have a thin gingival phenotype.[6] An average CW/CL of 0.80 was found in subjects with a thin phenotype compared with CW/CL of 0.87 for subjects with a thick phenotype.[10] The similar trend was demonstrated in this study that lower CW/CL presented in teeth with thin phenotype comparing to thick phenotype. The result supported the previous study which found the relationship between CW/CL and the probe visibility that determined thick or thin gingival biotype.[22] Regardless of the gingival phenotype, tooth with scalloped gingiva presented with a significant lower tooth proportion. This result is similar to previous findings where thin and thick-scalloped gingival contours were both related to a slender tooth form (CW/CL=0.77 and 0.79; Cluster A1; thin-scalloped and A2; thick-scalloped).[9] Thus, gingival contour may relate to tooth proportion rather than gingival phenotype assessed by gingival thickness.

The determination of tooth shape can be subjective. The result of correlation analysis between tooth dimension and gingival phenotype in this study signifies that a smaller CW/CL ratio is correlated with a greater PH. This is in agreement with the previous study which indicated that tooth shape was correlated with the extent of the keratinized mucosa, the gingival thickness and the papilla height.[17] Thus, teeth with scalloped gingival phenotype can appear more slender regardless of gingival thickness. In other words, triangular/ tapered teeth are correlated with scallop contour gingiva, while square teeth are correlated with flat contour gingiva.

Assessment of gingival biotype by visual assessment is simple and non-invasive. However, there are several limitations. It has been shown that simple visual inspection is not effective for identifying gingival biotype.[23,24] Regardless of clinicians' experience, the gingival biotype was correctly identified by visual inspection in only half of the cases, comparing to the cluster analysis.[23,24] The thick-scalloped biotype was accurately identified, while the thin-scallope biotype was the most misclassified.[24] This is crucial because a patient with the thin-scalloped biotype is considered high-esthetic risk. Additionally, the poor intra-examiner reliability of this method was demonstrated.[23] Identifying gingival biotype as thick or thin using the transparency probing method was shown to be more accurate than visual assessment when comparing to the direct measurement.[25] Thus, the transparency probing should be use to classify the thick/thin gingival biotype. The method of gingival biotype assessment has been discussed in our previous study.[14]

The association between CW/CL and gender was not evaluated in this analysis. However, our previous study showed no significant association between tooth shape and gender.[14] In this study, there was similar CW/CL between tooth shape. Therefore, it was implied that the CW/CL was similar between male and female, which

supported the other investigation.[21] The subjects of this study limited to young adults with healthy periodontium and no history of orthodontic treatment. Tooth position may affect the characteristics of gingival phenotype. Additionally, gingival recession tends to occur over time with aging or from periodontal diseases. Further longitudinal studies should be performed to determine tooth dimensions and other related gingival parameter according to age.

Because both gingival- and tooth-based factors determine the esthetic appearance of a tooth, a proper evaluation of the appearance of the tooth and gingiva is important for treatment planning to achieve the best esthetic outcomes.[6] For esthetic assessment, tooth shape and tooth dimension should be analyzed. Transparency probing along with visual inspection method should be used to evaluate characteristics of the gingival phenotype. Within the limitation of this study, tooth proportion is suggested to be 0.84 to achieve tooth appearance with scalloped gingiva.

Conclusions

Ovoid and square type made up with the similar tooth proportion, while triangular type tends to have lower tooth proportion. Triangular/ tapered teeth are correlated with scalloped gingival contour, while square teeth are correlated with flat gingival contour. Tooth proportion is associated with PH and the gingival contour rather than the gingival thickness. Evaluation of the tooth dimension and gingival phenotype will be beneficial for esthetic risk assessment.

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